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THEORETICAL INVESTIGATION ON ADVANCED ORCs

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ABSTRACT

This work investigates the use of advanced organic Rankine cycle designs to exploit a low temperature and a medium grade energy source represented by a solar application and waste heat from a marine diesel engine, respectively. Regarding the latter, we consider two different operating points: full load and at 60 % load. To improve the ORC efficiency and net power output of the classic one stage cycle, different cycle configurations have been considered, such as double stage (DS) and two pressure levels (2PL) systems. The thermodynamics and processes of the different organic Rankine cycles, as well as the heat source models, are described in details and the many assumptions and constrains are pointed out.

A thermodynamic optimization and fluid comparison has been carried out for each configuration by means of the numerical software EES, which allows to compute the thermo-physical properties of the considered fluids throughout the whole cycle. Heat exchange is described with the pinch point approach. The ORC performances of each system are compared in terms of different indices such as cycle efficiency, total energy output and power output. Moreover, in order to partially take into account an economic evaluation of the investigated power plants, we have introduced two more parameters: the volumetric expansion ratio (VER) and the total heat transfer capacity (ΣUA_{tot}).

The results show a slight superiority of advanced systems compared to single stage configurations in terms of thermal efficiency and power/energy output for both heat sources. Yet, taking into account the economic parameters like the complexity of the advanced power plants due to the introduction of more than one expander and additional heat exchangers, one stage systems appear to be the better way to utilize both low-grade thermal energy sources.